Proceedings, Applied Reproductive Strategies in Beef Cattle
August 31 – September 1, 2011; Joplin, MO

A REVIEW OF THE USE OF ULTRASOUND FOR REPRODUCTIVE PURPOSES IN BEEF CATTLE

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Introduction

For many years, rectal palpation has been a mainstay to veterinarians for pregnancy diagnosis. Undoubtedly, it will continue to be important for palpation of the reproductive tract of the cow (Kasimanickman 2011). To the experienced practitioner, it is most reliable $\geq$ 35 days post breeding (Kastelic et al., 1988; Mortimer and Hansen, 2006; Ramano et al., 2006). However, of growing importance in the last 15 to 20 years is the use of ultrasound for bovine reproduction because of its many benefits (Jones and Beal, 2003; Stroud 2006a).

Ultrasound has been investigated for approximately 25 years (Fricke and Lamb, 2005; Stroud, 2006a,b). Some of the earliest papers came out of Dr. Ollie Ginther's lab at the University of Wisconsin. The ultrasound provides the practitioner a way to gather more information than via rectal palpation (Lamb and Fricke, 2004; Ramano et al., 2006). The ultrasound was investigated as a tool for early pregnancy diagnosis, ovarian structures, fetal sexing, fetal aging, etc. (Beal et al., 1992; Fricke, 2006; Jones and Beal, 2003; Lamb and Fricke, 2004; Ribadu and Nakao, 1999). Initially, the high cost of the ultrasound machines dissuaded the use. Yet, because of advances in technology over the past 15 years, use of the ultrasound has been increased due the development of relatively inexpensive, portable equipment (Jones and Beal, 2003).

Most ultrasound units, which are used for reproductive purposes in cattle, have transducers in the 5-9 MHz range. Transducers in the 5.0 to 7.5 MHz frequency ranges are the most commonly used (Fricke and Lamb, 2005). The 5 MHz transducer results in greater depth (1-3 inches) but less detail in comparison to the 7.5 MHz (Fricke and Lamb, 2005; Stroud, 2006a). Crystals in the transducers create a sound wave to travel through the environment. Tissues will cause the waves to echo back, but fluids will not echo back (Jones and Beal, 2003; Stroud, 2006a). Therefore, fetal fluids will show up black on the ultrasound, whereas bones and tissue will be white to shades of grey.

Ultrasound as a Tool for Veterinary Practitioners in Reproductive Management

On the average, the embryo, with a heartbeat visible, is first visualized around day 20-28 of gestation (Baxter and Ward, 1997; Curran et al., 1986; Kastelic et al., 1988). A typical benefit seen among practitioners using ultrasound is that they often become more proficient at rectal palpation (Jones and Beal, 2003; Lamb and Fricke, 2004; Stroud, 2006a). The authors would concur with this statement. Several studies also show that there are very little deleterious effects of rectal palpation by the experienced veterinarian (Fricke, 2006; Thurmond and Picanso, 1993). However, there have been some papers suggesting an increase in fetal loss after rectal palpation vs. ultrasound. This problem is usually because of inexperienced palpators (Richardson et al.,

2010). Likewise, there have been several papers that indicate potential problems in fetal development from palpation of early pregnancies (Jones and Beal, 2003; Ramano et al., 2006; Ramano et al., 2007).

In more detail, some research described the sensitivity and specificity at various dates after insemination/breeding as early as 9-10 days post breeding (Jones and Beal, 2003; Lamb and Fricke, 2004; Nation et al., 2003). By 26-32 days post breeding, the sensitivity specificity is such that it is acceptable to efficiently diagnose a pregnancy/non-pregnancy at this time (Beal et al., 1992; Fricke and Lamb, 2005; Jones and Beal, 2003; Lamb and Fricke, 2004; Mohamed and Abd El-Aty, 2010; Ramano et al., 2006). With this knowledge, subsequent fetal loss after ultrasound is negligible (Ramano et al., 2006; Ribadu and Nakao, 1999; Richardson et al., 2010). So what is the benefit of ultrasound use for the cattleman? The actual goal of utilization of the ultrasound in dairy cattle is making a definitive non-pregnant diagnosis, so the cows can be resubmitted to be inseminated. This time-saver can enhance reproduction, which will lead to more profit.

In contrast to dairy cattle, an ultrasound is used in beef cattle more for fetal aging and/or fetal sexing (Fricke and Lamb, 2005). Fetal aging is important to seedstock producers to determine accurate sires and dams (Fricke and Lamb, 2005). Similarly, as commercial producers enter value-based markets, there is the need to know the genetic base of their cattle. Determining exact sire identification is enhanced through the use of ultrasound (Fricke and Lamb, 2005).

For cattlemen interested in extra profits through special programs, ultrasouding is essential. A majority of beef herds will choose a time to pregnancy check that minimizes trips through the chute. The Show-Me-Select Replacement Heifer (SMS) program in Missouri requires a palpation by 90 days after the start of the breeding season, whether bull bred or fixed-time artificial insemination (FTAI). This timing has been beneficial to the veterinarian performing the ultrasound, as it allows (in a fixed-time artificial insemination program) owners to determine the AI bred animals from the cleanup bull (if the bull is put into the herd 14 days after FTAI). Likewise, the veterinarian can fetal sex the FTAI inseminations and most likely the first round of bull inseminations (~ 70 days).

Fetal aging is also possible to detect through ultrasound. This can be determined by making various measurements of the fetus depending on the stage of gestation. Dr. Sandra Curran and coworkers first characterized the growth of the embryo/fetus (Curran et al., 1986). The most accurate estimate of gestational age is derived from taking an actual anatomical measurement (Jones and Beal, 2003; Mortimer and Hansen, 2006; Ribadu and Nakao, 1999). Early in the pregnancy (20-55 days of gestation), it is recommended that the crown to rump length be used (Jones and Beal, 2003; Lamb and Fricke, 2004). Later, the head or body circumference and/or the length of the head can be used to determine the gestational age of the fetus (Jones and Beal, 2003; Table 1). Using the above measurements, the actual date of calving was predicted within an average of 4.5 days (crown to rump), 6.9 days (head) or 7.8 days (trunk; Jones and Beal, 2003). Thus, the earlier the diagnosis, the more accurate the veterinarian will be.

As part of the SMS program, several livestock specialists have followed calving results of heifers sold through the sales. They have correlated the resulting calving dates with estimation of

breeding dates corresponding to whether the heifers were diagnosed via rectal palpation or ultrasound. The data would suggest that the use of the ultrasound improves the accuracy of the veterinarian, although several very experienced practitioners have very high accuracies. This would correlate with a recently published paper on the use of per rectum palpation, i.e. experienced palpators can be quite accurate while less experienced veterinarians are less accurate (Kasimanickam et al., 2011).

Referring once more to the beginning of ultrasound research for cattle, fetal sexing was first described in 1989 by Dr. Sandra Curran (Curran et al., 1989; Stroud, 2006b). She discovered that around day 53-56 days of gestation, the genital tubercles have migrated to their proper positions (Curran et al., 1989; Fricke and Lamb, 2005; Jones and Beal, 2003; Ribadu and Nakao, 1999; Stroud, 2006b). In general, the female genital tubercle will be under the tail earlier than the male genital tubercle will be caudal to the umbilical cord (Curran et al., 1989). Therefore, the earliest practitioners can practically fetal sex is 55 days (Beal et al., 1992; Curran et al., 1989). The latest fetal sexing can be done varies, but around 100 days of gestation in dairy cattle and 110 days in beef cattle; the gravid uterus becomes more difficult to scan. It is generally concluded that sex determination is most practical between 60-85 days of gestation (Jones and Beal, 2003; Lamb and Fricke, 2004; Ribadu and Nakao, 1999). For teaching purposes, the authors prefer the cattle to be 70-85 days of gestation.

Remarkably, fetal sexing can predict the sex of the resulting calf by 92-100% (Lamb and Fricke, 2004; Fricke and Lamb, 2005; Ribadu and Nakao, 1999; Stroud, 2006b). One should not be discouraged realizing that this level of accuracy will take time and practice to achieve. The genital tubercles both will appear as oval, hyperechogenic, bilobed structures (Curran et al., 1989; Stroud, 2006b). The male genital tubercle (MGT) will be found just caudal to the umbilicus, and the female genital tubercle (FGT) is located ventral to the tail (Stroud, 2006b).

There are two steps to learning to fetal sex. Step 1 is being able to identify the genital tubercles (relatively easy; Stroud 2006b). Step 2 is learning to produce an image that is of high quality—which is the more difficult step (Stroud 2006b). Cross sectional views appear to be the more useful for fetal sexing as opposed to saggital views (Curran 1989).

Additional helpful information while learning to ultrasound cattle is that the veterinarian will need to know which direction is cranial/caudal and ventral/dorsal. Having a handle on these anatomical directions will allow the ultrasonagrapher the ability to create the high quality image. There are three specific anatomical references, the head, beating heart, and umbilicus (Curran et al., 1989; Stroud, 2006b). These sites will help direct the practitioner to the correct direction when manipulating the transducer. Also, because the front and rear legs can be confusing, these references will help differentiate them (Stroud, 2006b). Definitive diagnosis is made my visualizing the genital tubercle. At approximately 80-90 days of gestation, secondary anatomic structures can improve diagnosis (Stroud, 2006b). In the bull the scrotum is visible and in the heifer the teats become distinctive (Stroud, 2006b).

Taking time to learn the art of pregnancy diagnosis for cattle by ultrasound has many benefits. The early detection of pregnancy, fetal sexing, aging, ovarian and uterine pathology, etc., all aid the cattleman to increase profits.

Table 1. (Adapted from Drs. Jill Colloton and Brad Stroud)

Days pregnant	Primary structure	Size	Secondary structure	Size	Tertiary structure	Size
< 30	Crown to rump	0.9 cm	-----	---	-----	---
35	Crown to rump	1 cm	-----	---	-----	---
40	Crown to rump	2 cm	-----	---	-----	---
45	Crown to rump	3 cm	-----	---	-----	---
50	Crown to rump	4 cm	Head diameter	0.7 cm	-----	---
55	Crown to rump	5 cm	Head diameter	1.1 cm	-----	---
60	Head Length	2.5 cm	Head diameter	1.5 cm	-----	---
70	Head Length	3 cm	Head diameter	2 cm	-----	---
75	Head Length	3.5 cm	Head diameter	2.3 cm	trunk diameter	2.5 cm
80	Head Length	4 cm	Head diameter	2.5 cm	trunk diameter	3 cm
85	Head Length	4.5 cm	Head diameter	2.8 cm	trunk diameter	3.5 cm
90	Head Length	5 cm	Head diameter	3.1 cm	trunk diameter	4 cm
95	Head Length	5.5 cm	Head diameter	3.5 cm	trunk diameter	4.5 cm
100	Head Length	6 cm	Head diameter	4 cm	trunk diameter	5 cm
105	Head Length	7 cm	Head diameter	4.5 cm	trunk diameter	6 cm
110	Head Length	8 cm	Head diameter	5 cm	trunk diameter	7 cm

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